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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte CHIN-TA SU

Appeal 2009-2986
Application 10/719,759
U.S. Patent Publication 2005/0109608

Decided: August 20, 2009

Before: FRED E. McKELVEY, *Senior Administrative Patent Judge*, and RICHARD TORCZON and MICHAEL P. TIERNEY, *Administrative Patent Judges*.

McKELVEY, *Senior Administrative Patent Judge*.

DECISION ON APPEAL

A. Statement of the case

Macronix International Co., Ltd, of Hsinchu, Taiwan ("Macronix"), the real party in interest, seeks review under 35 U.S.C. § 134(a) of a final rejection (mailed 7 September 2007).

The application on appeal was filed on 20 November 2003.

Claim 1-2, 6-8, 12-13 and 17 are in the application.

The Examiner relies on the following prior art:

Besser	U.S. Patent 5,970,370	19 Oct. 1999
Giewont	U.S. Patent 6,388,327	14 May 2002

The reader should know that "et al" is not used in this opinion.

Besser and Giewont are prior art under 35 U.S.C. § 102(b).

We have jurisdiction under 35 U.S.C. § 134(a).

B. Findings of fact

The following findings of fact are supported by a preponderance of the evidence.

References to the specification are to U.S. Patent Publication 2005/0109608 A1.

To the extent that a finding of fact is a conclusion of law, it may be treated as such.

Additional findings appear in the Discussion portion of the opinion.

The invention

The invention can be understood with reference to (1) Fig. 1, Fig. 2 and Fig. 4—all of which are reproduced below—and (2) an annotated version of claim 1.

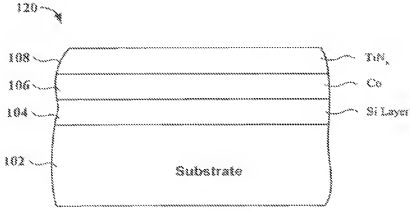

FIG. 1

Fig. 1 depicts a cross-section of a semiconductor

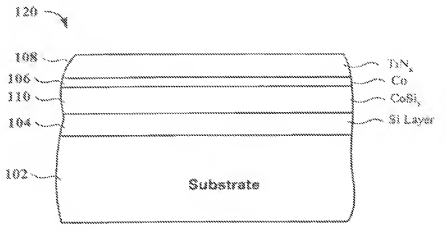

FIG. 2

Fig. 2 depicts a cross-section of a semiconductor after a first thermal process

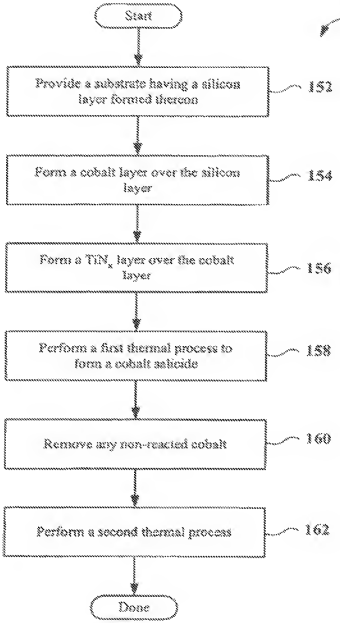

FIG. 4

Fig. 4 depicts a flow chart diagram illustrating the method steps

Claim 1, reproduced from the claims appendix of the Appeal Brief, reads as follows [bracketed matter, drawing numbers and some indentation added]:

Claim 1

A method of improving a thermal stability for cobalt salicide, comprising:

[1] providing [Fig. 4 152] a substrate [Fig. 1 102] having a silicon layer [Fig. 1 104] thereon;

[2] forming [Fig. 4 154] a cobalt layer [Fig. 1 106] over the silicon layer [Fig. 1 104];

[3] forming [Fig. 4 156] a TiN_x layer [Fig. 1 108] over the cobalt layer [Fig. 1 106];

[4] performing a first [Fig. 4 158] thermal process to form a cobalt salicide layer [Fig. 2 110]over the silicon layer [Fig 2 104], the performing of the first thermal process including:

[a] diffusing cobalt into the silicon layer to form the cobalt salicide layer [compare Fig. 1 with Fig. 2];

[b] diffusing nitrogen in the TiN_x layer into the cobalt salicide layer [specification ¶ 0011 and ¶ 0024]; and

[c] minimizing a diffusion of the Ti from the TiN_x layer into the silicon layer [specification ¶ 0024];

and

[5] removing [Fig. 4 160] a non-reactive cobalt layer;

wherein

> [a] the TiN_x layer is formed by a sputtering process [using a gas mixture including at least N_2 and Ar (argon)], [and]
>
> [b] a [sic—the] ratio of N_2 to Ar [argon] in a [sic—the] gas used in the sputtering process is approximately 3:1.

Comments on claim 1

Claim 1 is not a model of clarity.

(1)

We are not sure what is meant by "improving". The claim does not specify improvement over "what". We have considered part of ¶ 0006 and all of ¶ 0007 of the Specification:

> Therefore, in conventional semiconductor manufacturing processes, cobalt salicide processing is typically only used in mid- and back-end processes to avoid process temperatures that are too high. In some conventional applications, a titanium (Ti) or a titanium nitride (TiN) layer is formed on the cobalt layer to avoid cobalt oxidation, but thermal stability remains a challenge.
>
> [0007] In consideration of the foregoing, what is needed is a method of improving the thermal stability of cobalt salicide to enable use of desirable cobalt salicide processes in front-end processing.

Based on ¶¶ 0006 and 0007, we guess Macronix means improvement of the thermal stability such that the product of the process of claim 1 can be

used in "front-end processing" (a phrase with which we are not familiar). Giewont also describes improved thermal stability. Col. 2:35-36

The general steps set out in claim 1 are discussed in the prior art and because the "preamble" in no way breathes life into the meaning of the claim, the precise nature of any "improvement" is not a consideration in evaluating the obviousness of the subject matter claimed. We note that independent claim 7 does not contain the confusing language of the preamble of claim 1.

(2)

Improving "a thermal stability" is also confusing due to the presence of the word "a". The word "a" suggests that there are different thermal stabilities which might be improved. Insofar as were are aware, "thermal stability" is a single property. Accordingly, we are not sure what is mean by "a" thermal stability. We will construe "a" to mean "the." *Cf.* Specification, ¶ 0007.

(3)

Some limitations in [5] give us pause. There is no clear antecedent requirement that the sputtering process use a mixture of nitrogen and argon. The word "a" in "a ratio" and "a gas" is confusing. For the purpose of deciding the appeal, we will construe limitation [5] as set out above including the bracketed clarifications.

(4)

To resolve the appeal, we have construed claim 1 consistent with our bracketed annotations in claim 1 as reproduced above.

Examiner's rejection

The Examiner rejected the claims on appeal as being unpatentable under 35 U.S.C. § 103 over Giewont and Besser.

C. Discussion

Claim 1, as interpreted above, requires a sputtering process using a gas comprising nitrogen (N_2) and argon (Ar) where in the ratio of nitrogen to argon is "approximately 3:1."

The Examiner found that Giewont describes the general process claimed by Macronix.

With respect to the nitrogen to argon ratio, the Examiner relies on Fig 2. of Giewont, reproduced below.

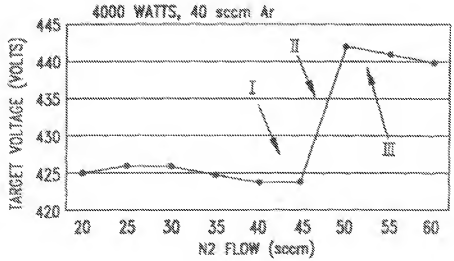

FIG. 2

Giewont Fig. 2 depicts a graph illustrating the relationship between target voltage and nitrogen flow in a sputtering process

Fig. 2 explicitly describes the use of a ratio of nitrogen to argon from 0.5:1 (when nitrogen is 20 and argon is 40) to 1.5:1 (when nitrogen is 60 and argon is 40).

The precise meaning of "approximately" in the phrase "approximately 3:1" is not apparent. Moreover, we find no guidance in the specification to assist one skilled in the art to determine the meets and bounds of "approximately" in the context of the invention. Nevertheless, the Examiner determined that a ratio of "approximately 3:1" differs from a ratio of "1.5:1" explicitly described by Giewont. Examiner's Answer, page 4:3-4.

To overcome the difference, the Examiner relies on the following general teaching of Giewont (col. 2:28-31) (italics added):

> [a]s noted above, the conventional TiN in capping layer 3 is generally not truly stoichiometric, but includes *additional nitrogen*. Nitrogen atoms may thus diffuse out of the capping layer 3 into and through the cobalt layer 2.

Based on Giewont's statement, the Examiner reasoned that it would have been obvious to use a nitrogen to argon ratio of approximately 3:1. Examiner Answer's, page 4. Why? Because a high nitrogen to argon ratio (1) would allow formation of a film that has excess nitrogen (*id.*) and (2) can lead to thermal stability (col. 2:35-36).

Responding to the Examiner's findings and conclusions, Macronix, points out that Giewont also teaches (col. 2:33-56):

> [a]lthough possible beneficial effects of introducing nitrogen into a self-aligned $CoSi_2$ are known (for example, improving thermal stability to agglomeration),

the involvement of nitrogen in the cobalt salicide formation process has an undesirable effect. Specifically, diffusion of N atoms from the TiN capping layer 3 to the oxide layer 11 (see FIG. 4A [not reproduced]) may result in formation of an oxynitride layer 21, which blocks diffusion of Si atoms 10 to the cobalt layer 2 (FIG. 4B; compare FIG. 3B [neither Fig. reproduced]). A thick oxynitride may also inhibit transport of Co atoms. This results in incomplete formation of the CoSi, with a layer 22 of unreacted Co above the oxynitride 21 after the first anneal (FIG. 4C [not reproduced]; compare FIG. 3C [not reproduced]). This Co layer 22 is stripped away with the TiN capping layer 3, leaving a thin layer of CoSi. This in turn results in a thin layer 25 of $CoSi_2$ being formed in the second anneal (FIG. 4D [not reproduced]). Discontinuities in the $CoSi_2$ layer 25 (that is, incomplete coverage of the Si gate 1) have been observed.

There is therefore a need for a capping layer for the cobalt metal which in general controls the introduction of N into the cobalt prior to formation of the $CoSi_2$, and in particular avoids formation of an oxynitride between the cobalt and silicon, thereby permitting complete formation of the CoSi.

Macronix reasons that the quoted portion of Giewont would discourage the use of the claimed nitrogen to argon ratio to avoid formation of oxynitride between the cobalt and silicon. Appeal Brief, page 11.

The Examiner was not impressed. The Examiner found that Giewont tells one skilled in the art that additional nitrogen has a benefit—"improving thermal stability to agglomeration" (col. 2:35-36). Examiner's Answer, page 6, second full paragraph. Moreover, the Examiner correctly found that the claims on appeal do not exclude the presence of an oxynitride layer. Examiner's Answer, page 6, first full paragraph.

On the one hand, Giewont states that more nitrogen can be used, but only explicitly describes up to 1.5:1 nitrogen to argon ratio. On the other hand, Giewont also teaches why too much nitrogen is not a good thing. But, Giewont says additional nitrogen provides a benefit of adding additional nitrogen and the claims on appeal do not exclude the presence of oxynitrides. In addition, since Giewont advises one skilled in the art when to stop increasing the nitrogen to argon ratio (*i.e.*, when oxynitrides become a problem) and suggests that additional nitrogen may be added, we feel comfortable finding that one skilled in the art would have used any suitable nitrogen to argon ratio which would avoid unacceptable oxynitride formation. Based on our review of the record (and giving Macronix the benefit of the doubt that its claimed process does not result in a product with unacceptable oxynitrides), one skilled in the art would know to use a ratio of nitrogen to argon which is "approximately 3:1" (as well as perhaps other lower or higher acceptable ratios).

Macronix does not tell us (1) why the "approximately 3:1" ratio is significant vis-à-vis formation of oxynitrides or (2) what result, if any, is obtained using that ratio that is not otherwise obtained. *Cf. In re Woodruff*, 919 F.2d 1575, 1578 (Fed. Cir. 1990) (where the difference between the claimed process invention and the prior art is some range or other variable within the claims, the applicant must show that the particular range is *critical*, generally by showing that the claimed range achieves unexpected results relative to the prior art range); *In re Aller*, 42 CCPA 824, 826, 220 F.2d 454, 456 (CCPA 1955) (normally, it is to be expected that a change in concentration would be an unpatentable modification unless a new and unexpected result is obtained).

Macronix does not single out other limitations for consideration. Accordingly, Macronix has failed to show on appeal that the Examiner erred in rejecting the claims on appeal over the prior art.

D. Decision

Macronix has not sustained its burden on appeal of showing that the Examiner erred in rejecting the claims on appeal as being unpatentable under § 103 over the prior art.

Upon consideration of the appeal, and for the reasons given herein, it is

ORDERED that the decision of the Examiner rejecting claims 1-2, 6-8, 12-13 and 17 the prior art is *affirmed*.

FURTHER ORDERED that no time period for taking any subsequent action in connection with this appeal may be extended under 37 C.F.R. § 1.136(a)(1)(iv) (2008).

AFFIRMED

ack

cc (via First Class mail)

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